

## PATENT ABSTRACTS OF JAPAN

(11) Publication number :

2000-123978

(43) Date of publication of application : 28.04.2000

(Abstract plus  
JPO machine  
translation)

(51) Int.CI.

H05B 33/22  
H05B 33/10  
H05B 33/14  
H05B 33/26

(21) Application number : 10-297893

(71) Applicant : CHISSO CORP

(22) Date of filing : 20.10.1998

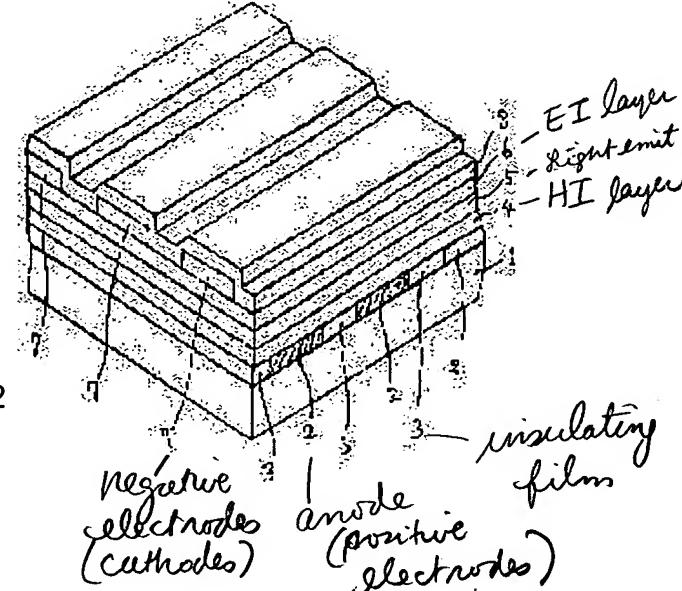
(72) Inventor : FURUKAWA KENJI  
IZUMISAWA YUSHO  
KOIKE TOSHIHIRO

## (54) ORGANIC EL ELEMENT AND MANUFACTURE THEREOF

## (57) Abstract:

**PROBLEM TO BE SOLVED:** To eliminate crosstalk caused by a leakage current, light emission blur, the increase of negative electrode resistance value and the disconnection of negative electrodes by providing an insulating film for filling a space between a positive electrode and a positive electrode.

**SOLUTION:** An insulating film 3 is provided between a positive electrode 2 and a positive electrode 2 in almost the same thickness as the positive electrodes 2 to make step difference formed between the positive electrodes 2 extremely small. All of organic layers such as a hole injection transport layer 4, a light emitting layer 5 and an electron injection transport layer 6 are therefore almost flat layers of uniform thickness without forming a thin part, so that the electric field formed between the positive electrodes 2 and negative electrodes 7 is uniform. As a result, a leakage current and dielectric breakdown are hardly generated to prevent crosstalk and light emission blur. A plurality of negative electrodes 7 of band shape are provided on the surface of the electrode injection transport layer 6 parallel at spaces in a right-angled direction to the positive electrodes 2. Since the negative electrodes 7 are formed on a flat multilayer film, no thin part is formed to prevent the increase of resistance.



value and the disconnection of the negative electrodes.

---

#### LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

## \* NOTICES \*

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

---

## DETAILED DESCRIPTION

---

### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to an organic EL element and its manufacture method.

[0002]

### [Description of the Prior Art]

[0003] Conventionally, the organic EL element has the structure which carried out the laminating of an anode plate, an organic luminous layer, and the cathode to this sequence on a transparent substrate like glass, and the organic EL element which performs the display of a character or a figure has the structure where make an anode plate and cathode cross and a dot matrix is formed. There are kinds of organic luminous layers, such as a multilayer which constituted from a layer two or more three layers, hole-injection transporting beds, and electron-injection transporting beds which consist of the bilayer and hole-injection transporting bed which consist of the monolayer, hole-injection transporting bed, and electron-injection transporting bed of an organic compound, a luminous layer, and an electron-injection transporting bed, respectively, and there are some which enabled the full color display further equipped with the organic luminous layer of three colors of red-green blue between the hole-injection transporting bed and the electron-injection transporting bed. In this structure, when it energizes between an anode plate and cathode, the phenomenon called so-called cross talk in which the leakage current flows between anode plates other than the point that an anode plate and cathode crossed, and cathode, and the point wanting [ un- ] emits light may happen. Moreover, the phenomenon of "bleeding" of luminescence may also happen.

[0004] Conventionally, the 1st example of an organic EL element known is explained using drawing 8.

[0005] ITO (indium stannic-acid ghost) is transparent on the transparent substrates 1, such as glass, -- using a conductor, two or more band-like anode plates 2 are formed so that each may become parallel. The hole-injection transporting bed 4 is formed on this anode plate 2. A luminous layer 5 is formed on the hole-injection transporting bed 4. The electron-injection transporting bed 6 is formed on a luminous layer 5. Cathode 7 is formed in the direction which intersects perpendicularly in an anode plate 2 on the electron-injection transporting bed 6. The hole-injection transporting bed 4, a luminous layer 5, and the electron-injection transporting bed 6 are insulators.

[0006] Thus, the constituted organic EL element produces a level difference at the end of an anode plate 2, and the thickness of the organic layer which consists of the hole-injection transporting bed 4 formed in the level difference portion, a luminous layer 5, and an electron-injection transporting bed 6, and cathode 7 becomes thin. If an organic layer becomes thin, the interval between an anode plate 2 and cathode 7 will become narrow, field strength will increase, and the leakage current will become easy to flow between an anode plate 2 and cathode 7. This leakage current causes [ of a cross talk or bleeding of luminescence ] generating. Moreover, if an organic layer becomes thin, dielectric breakdown of an organic layer will become easy to happen, the short circuit between anode plate-cathode will take place, and the problem that an organic EL element will break arises.

[0007] Furthermore, the problem that resistance will increase if cathode 7 becomes thin, and generation of heat increases not only arises, but depending on the case, cathode 7 is disconnected and the problem that an organic EL element will be destroyed arises. If an anode plate 2 must be made thin if it is going to make a level difference small in order to solve this problem, and an anode plate 2 is made thin, the problem that the resistance of an anode plate increases will arise. If an anode plate must be thickened if it is going to make the resistance of an anode plate small, and an anode plate is thickened, a level difference will become large and the above-mentioned problem will arise. Some proposals for reducing bleeding of a cross talk and luminescence among these problems are made.

[0008] The 2nd example of a certain organic EL element is explained using drawing 9 from the former. This manufacture method is a method indicated by JP,3-233891,A.

[0009] first, as shown in drawing 9 (a), ITO (indium stannic-acid ghost) is transparent on a glass substrate 31 -- a conductor is formed by the sputtering method or the vacuum deposition, and it forms so that each may become parallel about two or more band-like anode plates 32 by the lithography method

[0010] Next, as shown in drawing 9 (b), the electron hole transporting bed 33 is formed by the vacuum deposition etc.

[0011] Next, as shown in drawing 9 (c), the EL layer 34 of the shape of two or more island is formed along with an anode plate 32 by the vacuum deposition etc. on the electron hole transporting bed 33. Thus, the EL layer 34 of two or more independent luminescence fields arranged in the shape of a matrix is formed.

[0012] next, the direction which intersects perpendicularly in an anode plate 32 on the electron hole transporting bed 33 in which the EL layer 34 was formed as shown in drawing 9 (d) -- and it is made to correspond so that each of the EL layer 34 may serve as an intersection, and cathode 35 is formed by the vacuum deposition

[0013] Next, as shown in drawing 9 (e), the insulating body whorl 36 is formed in the front face containing cathode 35.

[0014] Thus, it is said by forming the island-like EL layer 34 that it is effective in the cross talk around a luminescence field and bleeding of luminescence decreasing. However, since the electron hole transporting bed 33 is left behind in the level difference portion while it has been thin, and cathode 35 is directly put on it, field strength increases rather than an element conventionally which only a part without the EL layer 34 shows to drawing 8 by the interval between anode plate-cathode becoming narrow, the leakage current becomes easy to flow between an anode plate 32 and cathode 35, and the problem that the cross talk by the leakage current and bleeding of luminescence increase arises.

Moreover, since the interval between anode plate-cathode is narrow, the short circuit between anode plate-cathode becomes easy to take place, and it becomes easy to destroy an organic EL element.

[0015] Furthermore, the problem of a level difference becoming large rather than the conventional element of drawing 8 since two level differences are formed of an anode plate 32 and the EL layer 34 about cathode 35, the thickness of the cathode 35 in a level difference portion becoming conventionally thinner than elegance, and resistance increasing more, becoming easy to disconnect generation of heat not only increasing but the cathode 35, and becoming easy to destroy an organic EL element arises.

[0016] Furthermore, in order to make the EL layer 34 of two or more shape of an independent island arranged in the shape of a matrix form, an excessive mask is needed, and there is a problem that carrying out alignment of the opening of a mask to the crossing of an anode plate 32 and cathode 35 takes time and effort. Moreover, a man day starts manufacturing the mask which has such detailed opening, and there is a problem that a mask becomes expensive.

[0017] Drawing 11 is the cross section shown in order of the manufacturing process, in order to explain the 3rd example of a certain organic EL element from the former. The manufacture method of this organic EL element is a method indicated by JP,3-250583,A.

[0018] first, as shown in drawing 11 (a), ITO is transparent on a glass substrate 41 -- two or more anode plates 42 by the conductor are formed After removing the polyimide of the portion which applied the photosensitive polyimide to the front face, exposed through the mask of a luminescence pattern, developed, and was exposed, it heats in 300-degree C oven in 180-degree C oven for 30 minutes for 30

minutes, and the layer insulation film 43 of a polyimide is formed. The opening 44 of the layer insulation film 43 is formed only in the part on an anode plate 42, and the edge of an anode plate 42 is covered by the layer insulation film 43.

[0019] Next, cathode 46a which becomes a counterelectrode, installing [ having formed luminous layer 45a of the organic luminous layer which is stuck and emits light in a desired color, for example, the red luminescence organic substance, by vacuum evaporationo, and ] the same vacuum evaporationo mask 51 continuously after carrying out alignment so that the opening 52 of the vacuum evaporationo mask 51 may contain the opening 44 of the layer insulation film 43 inside as shown in drawing 11 (b) is formed by the vacuum deposition etc. When manufacturing a multicolor EL element, the anode plate 42 top of the next door in which green and a blue luminous layer are formed is covered with the mask 51.

[0020] Next, as shown in drawing 11 (c), the portion in which luminous layer 45a and cathode 46a were formed is covered. After carrying out alignment of the mask 53 which has opening 54 on the next anode plate 42 like a front, Cathode 46b which becomes a counterelectrode, installing [ having formed luminous layer 45b of the organic luminous layer which is stuck and emits light in a desired color, for example, the green luminescence organic substance, by vacuum evaporationo, and ] the same vacuum evaporationo mask 53 continuously is formed by the vacuum deposition etc. Formation of a blue luminous layer and the cathode on it is performed similarly.

[0021] Since who of vacuum evaporationo does not arise, this manufacture method says that the homogeneity of a luminescence side is high. Moreover, since exchange of the vacuum evaporationo mask of a luminous layer and the vacuum evaporationo mask of a counterelectrode is not needed, there is no contamination of a forming face and it is said that the element of the quality of an excellent article can be manufactured.

[0022] It explains using the cross section showing the trouble in the manufacture method of the organic EL element of the 3rd example of the above in drawing 12 .

[0023] As shown in drawing 12 (a), in fact, only the part of the thickness of an anode plate 42 produced the level difference, and layer insulation film 43b has produced the hollow. In drawing 11 , although the layer insulation film 43 between anode plate 42a and anode plate 42b is drawn evenly, as shown in drawing 12 (a) in fact, it has produced the hollow. Since the vacuum evaporationo particle from the source of vacuum evaporationo spreads and goes to a semi-sphere side when forming organic EL layer and cathode by vacuum deposition or the sputtering method, in the place except right above the source of vacuum evaporationo, incidence of the vacuum evaporationo particle is aslant carried out to a vacuum evaporationo-ed object. The incident angle of a vacuum evaporationo particle becomes larger, as it separates from right above the source of vacuum evaporationo. As shown in drawing 12 (a), when the vacuum evaporationo corpuscular ray 47 carries out inclination incidence, an opening 55 occurs into the portion which becomes the shadow of a mask 51. In the 3rd example, since organic luminous layer 45a and cathode 46a use the same vacuum evaporationo mask 51, its thickness of the vacuum evaporationo mask 51 must be thicker than the sum of the thickness of organic luminous layer 45a, and the thickness of cathode 46a. In fact, there are 10 micrometers or more of thickness of the vacuum evaporationo mask 51, and since the thickness of organic luminous layer 45a and cathode 46a is about 0.2-0.3 micrometers, an opening 55 will become large. So, it does not become the opening which was lined off as shown in drawing 11 (a), but becomes the opening to which the boundary faded by surroundings lump of a vacuum evaporationo particle.

[0024] As shown in drawing 12 (b), when forming organic luminous layer 45b and cathode 46b of another color on the next anode plate 42b, since a mask 53 is stuck and installed in cathode 46a, an opening 56 is made between insulator layers 43a-43c and a mask 53, and an opening 55 spreads. If vacuum evaporationo is performed in this state, the side of organic luminous layer 45b and cathode 46b will turn into an inclined plane, and will produce an opening 57 further. a these openings 56 and 57 sake -- a vacuum evaporationo particle -- a surroundings lump -- being easy -- vacuum evaporationo -- the problem who not only happens, but that a surroundings lump particle adheres to 42s of exposed surfaces of anode plate 42b, emits light from here, and it produces bleeding and the cross talk of luminescence arises

[0025] Moreover, in the 3rd example of the above, since the vacuum evaporation of a luminous layer and the vacuum evaporation of a counterelectrode are performed using the same mask, an anode plate and cathode become in the same direction, and do not cross in the right-angled direction. Therefore, although a line-like (shape of stripes) luminescence pattern can be obtained, the luminescence pattern of a dot matrix cannot be obtained but the fault that it cannot be used is shown in information displays, such as a character and a figure.

[0026] It explains using the perspective diagram showing the 4th example of an organic EL element known from the former in drawing 13. The manufacture method of this organic EL element is a method indicated by JP,4-51494,A.

[0027] ITO is transparent on a glass substrate 61 -- a conductor is formed by the sputtering method or the vacuum deposition, and it forms so that each may become parallel about two or more band-like anode plates 62 by the lithography method. Next, the insulator layer 63 which has Opening W is formed on the anode plate 62 of the position which intersects the cathode made later. One of them makes opening W a square smaller than the width of face of an anode plate 62 and cathode.

[0028] Next, the electron hole transporting bed 64 is formed by the vacuum deposition etc., and the organic EL layer 65 is formed on it. The electron hole transporting bed 64 and the organic EL layer 65 fall in the place of Opening W.

[0029] next, the direction which intersects perpendicularly in an anode plate 62 on the EL layer 65 -- and cathode 66 is formed so that Opening W may serve as an intersection with an anode plate 62. Since cathode 66 is made by width of face with larger Opening W than one side, it has covered Opening W, and it has fallen in the place of Opening W.

[0030] If it is made this structure, since Opening W is formed only in the position where an anode plate 62 and cathode 66 cross, the current from an anode plate 62 flows through Opening W and only the organic EL layer 65 in Opening W emits light, it is said that bleeding of luminescence and a \*\* cross talk do not happen. Moreover, although an insulator layer 63, an anode plate 62, and cathode 65 become thin in the level difference portion of an anode plate 62, since the insulator layer 63 was added, the interval between anode plate-cathode is large from before, and the leakage current and the short circuit between anode plate-cathode are reduced.

[0031] However, when forming Opening W in an insulator layer 63, in order to perform a photolithography processes of the application of a photoresist, exposure development, and etching of an insulator layer 63, there is a problem of taking the time and effort which carries out alignment since an excessive man day needs to carry out alignment to this top so that the mask for exposure may not shift from Opening W.

[0032] Moreover, since it is necessary to carry out alignment of the mask for cathode formation so that cathode 66 may not shift from Opening W at the time of cathode formation, in order to carry out alignment, there is a problem that time and effort takes 2 times. Furthermore, the mask for exposure is newly needed, and since the mask for exposure which has a detailed pore the top must be manufactured, there is a problem that the expensive mask cost for exposure starts too much. Moreover, although it is considered to be difficult work to form Opening W in an insulator layer 63 on the anode plate 62 of ITO, about the formation method, JP,4-51494,A does not indicate Opening W.

[0033] the 5th example of the conventional organic EL element is shown in drawing 14 -- a part is explained using a notch perspective diagram and a cross section. The manufacture method of this organic EL element is a method indicated by JP,7-22177,A.

[0034] ITO is transparent on the transparent substrates 71, such as glass and a plastic, -- a conductor is formed by the sputtering method or the vacuum deposition, and it forms so that each may become parallel about two or more band-like anode plates 72 by the lithography method next, an insulation -- a sexual feeling -- the phot which applies a photoresist and carries out exposure development -- the insulating non-luminous layer 73 which has a pore 74 is formed on an anode plate 72 by the lithography method. A luminous layer 76 is formed by the electrolytic polymerization method. as shown in drawing 14 (a), it can be further alike and a luminous layer 76 can also be carried out, and as shown in drawing 14 (b), it can also make a luminous layer the double hetero structure which consists of the electron hole

transporting bed 75, a luminous layer 76, and an electronic transporting bed 77. The insulating non-luminous layer 73 is formed in the same thickness as the sum total thickness of the sum total thickness of an anode plate 72 and a luminous layer 76 or an anode plate 72, the electron hole transporting bed 75, a luminous layer 76, and the electronic transporting bed 77. Next, an anode plate 72 forms cathode 78 in the direction which intersects perpendicularly on the non-luminous layer 73 and the electronic transporting bed 77.

[0035] If it is made this structure, since the power line is extended from an anode plate 72 in the shape of a straight line to cathode 78 since the non-luminous layer 73 exists, uniform electric field are formed and a luminous layer exists only on an anode plate 72, it is said that the outstanding organic EL element without bleeding and the cross talk of luminescence is obtained.

[0036] however, an insulation -- a sexual feeling -- the time of forming a pore 74 in a photoresist -- an insulation -- a sexual feeling -- in order to perform a photolithography processes of the application of a photoresist, exposure development, and etching of the non-luminous layer 73, there is a problem of taking the time and effort which carries out alignment since an excessive man day needs to carry out alignment to this top so that the mask for exposure may not shift from a pore 74. Moreover, since it is necessary to carry out alignment of the mask for cathode formation so that cathode 78 may not shift from a pore 74 at the time of cathode formation, in order to carry out alignment, there is a problem that time and effort takes 2 times. Furthermore, the mask for exposure is newly needed, and since the mask for exposure which has a detailed pore the top must be manufactured, there is a problem that the expensive mask cost for exposure starts too much.

[0037]

[Problem(s) to be Solved by the Invention] Although various proposals are made that the cross talk resulting from the level difference of an anode plate and bleeding of luminescence should be solved as explained above. By the level difference portion, in generating of the leakage current by the bird clapper, and the short circuit between anode plate-cathode, and a level difference portion, an organic layer is thin, and cathode is thin, and although it was left behind while the problem of increase of the cathode resistance by the bird clapper and an open circuit of cathode had been unsolved, or the above-mentioned problem was solved. Therefore, the manufacturing process increased, the man day increased, the expensive mask was needed, and there was a problem of becoming cost quantity.

[0038] Thinly, cathode is thin, an organic layer solves the problem of increase of the cathode resistance by the bird clapper, and an open circuit of cathode with an easy means by generating of the leakage current by the bird clapper, and the short circuit between anode plate-cathode, and the level difference portion, and the purpose of this invention does not have the cross talk by the leakage current, bleeding of luminescence, increase of cathode resistance, and an open circuit of cathode, and is to offer the organic EL element which can be manufactured by the low cost by the few man day

[0039]

[Means for Solving the Problem] (1) as for invention of the 1st of this invention, band-like [ which set the interval on the front face of a transparent substrate, and was prepared in it in parallel ] is transparent -- with the anode plate of a conductor. It is the organic EL element to which the aforementioned anode plate is characterized by having the band-like cathode which set the interval and was prepared in parallel in the right-angled direction at the front face of the insulator layer which fills between this anode plate and anode plates, the organic multilayer containing the luminous layer prepared in this anode plate and the front face of an insulator layer, and this organic multilayer.

[0040] (2) They are that invention of the 2nd of this invention has the refractive index of the aforementioned insulator layer equivalent to the refractive index of the aforementioned anode plate, or the organic EL element given [ aforementioned ] in the 1st term characterized by being smaller than it and being larger than the refractive index of the aforementioned transparent substrate.

[0041] (3) invention of the 3rd of this invention is transparent on the front face of a transparent substrate -- an anode plate band-like by the conductor with the process which sets an interval and are formed in parallel. The process which forms an insulator layer so that between this anode plate and anode plates may be filled, and the process which forms the organic multilayer containing a luminous layer in this

anode plate and the front face of an insulator layer, It is the manufacture method of an organic EL element that the aforementioned anode plate is characterized by having the process which sets an interval and forms two or more band-like cathode in parallel in the right-angled direction at the front face of this organic multilayer.

[0042] (4) invention of the 4th of this invention is transparent on the front face of the aforementioned transparent substrate -- an anode plate band-like by the conductor with the process which sets an interval and are formed in parallel the process which forms an insulator layer so that between this anode plate and anode plates may be filled -- the aforementioned transparent substrate -- the above -- transparent -- with the process which forms the film of a conductor this -- transparent -- with the process which forms a photoresist film on the film of a conductor, and the process from which only the field which forms the aforementioned anode plate leaves the aforementioned photoresist film, and removes others the above with which the aforementioned photoresist film is not covered -- transparent -- with the process which removes the film of a conductor It is the manufacture method of the organic EL element given [ aforementioned ] in the 3rd term characterized by the bird clapper from the process which puts an insulator layer on a front face with the aforementioned anode plate at the almost same thickness, and the process which removes the photoresist film on the aforementioned anode plate with the insulator layer on it.

[0043] (5) In invention of the 5th of this invention, the process which forms an insulator layer so that between the aforementioned anode plate and anode plates may fill is the manufacture method of the organic EL element given [ aforementioned ] in the 3rd term characterized by the bird clapper from the process which forms an insulator layer in the front face of a transparent substrate in which the aforementioned anode plate is formed with the aforementioned anode plate at the almost same thickness, and the process which carry out the polish removal of the aforementioned insulator layer until the aforementioned anode plate front face is exposed using the chemical mechanical grinding

[0044]

[Embodiments of the Invention] Invention of the 1st of this invention is explained using the perspective diagram showing the gestalt and example of the operation in drawing 1 .

[0045] ITO (indium stannic-acid ghost) is transparent on a transparent substrate 1 like glass -- an interval is set and two or more anode plates 2 band-like by the conductor are formed in parallel Although the width of face of an anode plate and especially the interval between anode plates were not limited, usually, the width of face of an anode plate is 1 micrometer - 1mm, and set the interval between 50 micrometers - 5mm and an anode plate to 500 micrometers in this example. The thickness of an anode plate 2 is formed in the thickness of 500nm. Although the thickness of an anode plate 2 is about 100-250nm conventionally, it is setting thickness to 500nm by this example in order to make the resistance of an anode plate the conventional half.

[0046] What is necessary is just to make thickness of an anode plate 2 one 5 times [ over the past ] the thickness of this to set resistance to conventional one fifth. In this invention, since the bad influence of the level difference by the anode plate is eliminable like the after-mentioned, thickness of an anode plate can be made into arbitrary thickness. An insulator layer 3 is formed in the thickness almost same on the front face of the transparent substrate 1 which is [ between anode plates ] exposed as an anode plate 2, and between an anode plate and anode plates is fill uped with an insulator layer. Since it is for making small the level difference by the anode plate 2, and eliminating the bad influence by the level difference, although it is desirable for an anode plate 2 and the front face of an insulator layer 3 to turn into the same flat surface as for burying by the insulator layer, since it is difficult to make it the same flat surface, the thickness of an insulator layer 3 is adjusted so that it may become the same flat surface as much as possible closely.

[0047] However, it is not close [ an anode plate 2 and the front face of an insulator layer 3 ] to the same flat surface. For example, since a level difference will become half if the thickness of an insulator layer 3 is increased the half of the thickness of an anode plate 2, or 1.5 times, the effect of only a part that the level difference became small is produced.

[0048] The hole-injection transporting bed 4 which constitutes an organic multilayer is formed in an

anode plate 2 and the front face of an insulator layer 3 by this example at the thickness of 50nm. Although especially the thickness of this hole-injection transporting bed 4 is not limited, it is usually about 10-100nm. Since the anode plate 2 and the front face of an insulator layer 3 are mostly formed in the same flat surface and there is no level difference, the hole-injection transporting bed 4 becomes almost flat, and does not strike a wave like before. As a material of the hole-injection transporting bed 4, N and N'-diphenyl N, the N'-screw (3-methylphenyl) 1, 1'-biphenyl 4, and a 4'-diamine (TPD) can be used.

[0049] A luminous layer 5 is formed by this example on the hole-injection transporting bed 4 at the thickness of 15nm. Although especially the thickness of this luminous layer 5 is not limited, as a material of this luminous layer, for example, tris (8-quinolinolato) aluminum (III) (Alq3) can usually be used by about 2-100nm.

[0050] On a luminous layer 5, the electron-injection transporting bed 6 which constitutes an organic multilayer is formed at the thickness of 35nm. Although especially the thickness of this electron-injection transporting bed 6 is not limited, either, it is usually 10-100nm, and 1 and 1-dimethyl 3, 4-diphenyl 2, and 5-screw {6-(2-pyridyl) pyridine 2-IRU} silacyclo pentadiene (PyPySLPyPy) can be used as a material of this electron-injection transporting bed, for example.

[0051] In an anode plate 2, an interval is set on the front face of the electron-injection transporting bed 6, and two or more band-like cathode 7 is formed in the right-angled direction in parallel on it. The width of face of this cathode and especially the interval between cathode were not limited, but usually, the width of face of cathode is 1 micrometer - 1mm, and set the interval between 50 micrometers - 5mm and cathode to 500 micrometers by this example. This cathode 7 is formed by carrying out vapor codeposition of Mg and Ag, and depositing an Mg-Ag alloy on the thickness of 200nm. Although especially the thickness of this cathode is not limited, either, it is usually 10nm - 1 micrometer, and aluminum, Mg, calcium, In, aluminum-Li, Mg-In, LiF/aluminum, aluminum<sub>2</sub>O<sub>3</sub>/aluminum, etc. can be used as a material of this cathode 7 in addition to Mg-Ag. Here, LiF/aluminum and aluminum<sub>2</sub>O<sub>3</sub>/aluminum mean the structure which deposited LiF or aluminum 2O3 on the thickness of 0.5-5nm, and deposited aluminum on it at the thickness of 10-200nm.

[0052] An insulator layer 8 is formed in cathode 7 and the exposed front face of the electron-injection transporting bed 6 at the thickness of 300nm. Although especially limitation does not have the thickness of an insulator layer 8, it is usually 1nm - 1 micrometer. As a material of this insulator layer, organic insulators, such as a photosensitive polycarbonate used, for example as the inorganic insulator and photoresist of SiO, SiO<sub>2</sub>, SiN, Si<sub>3</sub>N<sub>4</sub>, AlO<sub>2</sub> and aluminum 2O<sub>3</sub>, and Y<sub>2</sub>O<sub>3</sub> grade, polyester, and a polyimide, etc. can be used.

[0053] Since the insulator layer 3 of the almost same thickness as an anode plate 2 was formed between the anode plate 2 and the anode plate 2 and the level difference by the anode plate was made very small so that clearly from the above-mentioned explanation Since each of hole-injection transporting beds 4, luminous layers 5, and organic layers of electron-injection transporting-bed 6 grade turns into a layer of almost flat uniform thickness and a thin portion is not made Become uniform electric field, for this reason, the leakage current and dielectric breakdown stop being able to happen easily, and the electric field formed between an anode plate and cathode can prevent a cross talk and bleeding of luminescence.

[0054] Moreover, since cathode is formed on a flat organic multilayer, it cannot do a thin portion but produces neither increase of resistance, nor an open circuit of cathode. With the conventional structure without an insulator layer 3, the thickness of the organic layer of the hole-injection transporting bed 4, a luminous layer 5, and electron-injection transporting-bed 6 grade becomes very thin on the square of an anode plate 2, between an anode plate 2 and cathode 7 becomes narrow, field strength becomes large, and leak and dielectric breakdown of current tended to happen. For this reason, a cross talk and bleeding of luminescence tended to happen. Moreover, the thickness of cathode became thin in the level difference section, and increase and an open circuit of resistance were produced.

[0055] In this invention, since the thickness of an organic layer is uniform and a thin portion is not made by having formed so that an anode plate 2 and the front face of an insulator layer 3 might turn into the same flat surface mostly, the electric field formed between an anode plate 2 and cathode 7 turn into

uniform electric field, and leak of current, dielectric breakdown, and bleeding of luminescence do not produce it. Moreover, since cathode is formed in a flat side, it is fixed thin and it does not produce increase or an open circuit of the resistance in the level difference section like before.

[0056] Although forming an insulator layer 3 has the above effects, bleeding of luminescence is further improvable if the refractive index of an insulator layer 3 is chosen.

[0057] Next, it explains using the fragmentary sectional view (cross section of the organic EL element of drawing 1 ) of drawing 2 which limits the refractive index of an insulator layer 3 within the limits of specification and in which having shown the optical path for the gestalt and example of implementation of the 2nd invention.

[0058] Suppose that there was luminescence from one point [ of a luminous layer 5 ] P. Light L1 which carried out incidence at right angles to an anode plate 2 and the transparent substrate 1 It goes away from a transparent substrate transverse plane, without being refracted. Light L2 which carried out incidence to the anode plate 2 aslant It goes away from a transparent substrate transverse plane, being refracted. Light L3 which did not carry out incidence to an anode plate 2 Although it goes away from the transparent substrate transverse plane, being refracted, it is light L3. Since it is the light which comes out to fields other than an original luminescence field (field where an anode plate 2 and cathode 7 cross) non-emitting light and becomes bleeding of luminescence, I want to lessen such a light. If possible, it is light L4. It is made to go away on the side, repeating total reflection within the transparent substrate 1 like, or is light L5. It is made to go away on the side, repeating total reflection like among an insulator layer 3 or an insulator layer 3 and the anode plate 2, or is optical L6 -L7. It is made to go away to a luminescence field like.

[0059] Generally, it is a refractive index n1. A medium 1 and refractive index n2 The medium 2 has touched and light is an incident angle theta 1. Incidence is carried out to a medium 1 and it is an angle theta 2 with a medium 2. It will come, supposing it is refracted, and refraction is expressed with the following formula (1).

[0060]

[Equation 1]  $\sin\theta_1/\sin\theta_2 = n_2/n_1$  (1) [0061] And  $n_1 > n_2$  When it solves and a total reflection angle is set to  $\theta_{\text{tot}}$ , total reflection angle  $\theta_{\text{tot}}$  is expressed with the following formula (2).

[0062]

[Equation 2]  $\sin\theta_{\text{tot}} = n_2/n_1$  (2) [0063] The refractive index of each matter used in the example of invention of the above 1st is as in the below-mentioned table 1.

[0064]

[Table 1]

物質名	屈折率
SiO <sub>2</sub> (透明基板)	1.46
ITO (陽極)	1.8~2.1
TPD (正孔注入輸送層)	1.76
Alq <sub>3</sub> (発光層)	1.7

[0065] First, light L3 which comes out to the field non-emitting light Light [ like ] is lessened and it is light L4. I want to make [ many ] light [ like ] and to reduce bleeding of luminescence. It is required for the refractive index of an insulator layer 3 to be larger than the refractive index of the transparent substrate 1 for that purpose. The more the refractive index of an insulator layer 3 is larger than the refractive index of the transparent substrate 1, the more it is angle of refraction theta 2. Since it becomes large, the total reflection within the transparent substrate 1 becomes easy to happen. If it puts in another way, it will be light L4. Light [ like ] increases and it is light L3. Light [ like ] will decrease.

[0066] The refractive index of 1.46 and air is light L4, when the refractive index of the transparent substrate 1 makes the refractive index of an insulator layer 3 larger than the refractive index of the transparent substrate 1 since it is about 1, as shown in Table 1. Light L3 which increases light [ like ] and is shown in drawing 2 Light [ like ] can be lessened and bleeding of luminescence can be reduced.

[0067] When the refractive index of an insulator layer 3 is larger than the refractive index of the transparent substrate 1, it is light L5. The light which is going to go into an anode plate 2 so that it may go away on the side (in direction perpendicular to space) or may illustrate arises repeating total reflection within an insulator layer 3 like. In order to reduce bleeding of luminescence, it is desirable for light not to go to the field non-emitting light, but to make it go to a luminescence field. For that purpose, if the refractive index of an insulator layer 3 is equivalent to the refractive index of an anode plate 2 or smaller than it, it is light L5. It becomes easy to go into an anode plate 2 like. Therefore, it is larger than the refractive index of the transparent substrate 1, and the refractive index of an insulator layer 3 is equivalent to the refractive index of an anode plate 2, or it is desirable that it is smaller than it.

[0068] As shown in Table 1, although based also on the kind of material, there is much what is 1.7 to about 1.8, for example, when it is TPD, it is 1.76, and the refractive index of the hole-injection transporting bed 4 is larger than the refractive index of the transparent substrate 1, and smaller than the refractive index of an ITO anode plate. If the refractive index of an insulator layer 3 is larger than the refractive index of the hole-injection transporting bed 4, it is light L6. It enters and goes into the transparent substrate 1 to an insulator layer 3 continuously like, without carrying out total reflection.

[0069] Repeating total reflection within a transparent substrate with the incident angle to the interface of a transparent substrate and air, the light included in the transparent substrate 1 is left on the side (in direction perpendicular to space), or is left from a transparent substrate transverse plane. On the contrary, if the refractive index of an insulator layer 3 is smaller than the refractive index of the hole-injection transporting bed 4, it is light L7. It becomes easy to carry out total reflection by the interface with an insulator layer 3 like. Usually, since the refractive index of an anode plate 2 is larger than the refractive index of the hole-injection transporting bed 4, it goes into an anode plate 2 from the hole-injection transporting bed 4, and it goes into the transparent substrate 1 continuously, and the light left from a transparent substrate transverse plane increases.

[0070] The above explanation shows that injection of the light to the field non-emitting light will decrease, and bleeding of luminescence will decrease if the refractive index of an insulator layer 3 is made larger than the refractive index of the transparent substrate 1 smaller on a par with the refractive index of an anode plate 2 than it.

[0071] If it is in the 2nd invention, it turns out that the refractive index  $n$  of an insulator layer 3 should just choose the matter in the range of  $1.46 < n \leq 2.1$ . The matter name and refractive index which are satisfied [ with Table 2 ] of the above-mentioned range are shown.

[0072]

[Table 2]

物質名	屈折率
LaF <sub>2</sub>	1.59
NdF <sub>3</sub>	1.6
Al <sub>2</sub> O <sub>3</sub>	1.62
CeF <sub>3</sub>	1.63
PbF <sub>2</sub>	1.75
MgO	1.75
ThO <sub>2</sub>	1.8
SnO <sub>2</sub>	1.9
La <sub>2</sub> O <sub>3</sub>	1.95
SiO	1.7~2.0
In <sub>2</sub> O <sub>3</sub>	2.0
Nd <sub>2</sub> O <sub>3</sub>	2.0
Sb <sub>2</sub> O <sub>3</sub>	2.04
ZrO <sub>2</sub>	2.1

[0073] Drawing 3 is the property view of the voltage-current curve of elegance the example of invention of the 1st of this invention shown in drawing 1, and conventionally.

[0074] A curve 21 shows the property of the organic EL element obtained in the example of the 1st invention, and a curve 22 shows the property of elegance conventionally. Conventionally, except that there is no elegance of three insulator layer between an anode plate and an anode plate and between cathode and cathode, it is the same composition as the example of the 1st invention. Conventionally, to the leakage current having generated elegance in the low-battery field, this invention article does not have the leakage current and the good property is shown so that clearly from drawing 3. It is shown that that there is no leakage current does not have a cross talk.

[0075] Next, the gestalt and example of implementation of invention of the 3rd of this invention are explained using the perspective diagram of drawing 4.

[0076] The gestalt of implementation of this 3rd invention and its example are examples which form a luminous layer by two-layer [ of the hole-injection transporting bed 4 and the electron-injection transporting bed 6 ]. As a hole-injection transporting bed 4, N and N'-diphenyl N, the N'-screw (3-methylphenyl) 1, 1'-biphenyl 4, and a 4'-diamine (TPD) are formed in the thickness of 50nm, and for example, tris (8-quinolinolato) aluminum (III) (Alq3) is formed in the thickness of 50nm as an electron-injection transporting bed 6. Although especially the thickness of the hole-injection transporting bed 4 and the electron-injection transporting bed 6 is not limited, the thickness shown with the gestalt of implementation of invention of the 1st of the above-mentioned this invention can be illustrated. Except it, it is the same as the example of the gestalt of implementation of the 1st invention. And the same is said of the effect.

[0077] The example which formed the luminous layer 5 by one layer among the gestalten of implementation of the 3rd invention is explained using the perspective diagram of drawing 5.

[0078] The example shown in drawing 5 is an example which formed the luminous layer 5 by one layer. Although a luminous layer 5 is not limited as the gestalt of implementation of invention of the above 1st especially explained this thickness, although for example, tris (8-quinolinolato) aluminum (III) (Alq3) was formed in the thickness of 100nm, it is usually 30-300nm. Except it, it is the same as the example of the 1st invention. And the same is said of the effect.

[0079] It explains using the cross section having shown the gestalt of implementation of invention of the 4th of this invention, and its example in order of the process of drawing 6 .

[0080] first, as shown in drawing 6 (a), ITO is transparent on a transparent substrate 1 like glass -- a conductor -- it is a vacuum deposition, for example, a film is formed in the thickness of 500nm Besides, selection exposure is applied and carried out, a photoresist film is developed, and the mask 11 of a photoresist is formed. a mask 11 is made into protection material and ITO is transparent -- a conductor -- a film is \*\*\*\*\*ed and an anode plate 2 is formed An anode plate 2 is beltlike, sets an interval and are formed in parallel. [ two or more ] What is necessary is just to make the width of face of an anode plate, and the interval between anode plates the same as it of invention of the above 1st, respectively.

[0081] Next, the vacuum evaporationo of the SiO is carried out as an insulator layer 3, leaving the mask 11 of a photoresist, as shown in drawing 6 (b). A SiO film is formed in the almost same thickness as an anode plate 2. What is necessary is just to choose an insulator layer 3 from the matter shown in Table 2, as explained previously.

[0082] Next, as shown in drawing 6 (c), the mask 11 of a photoresist is removed. The insulator layer 3 on a mask 11 is removed with a mask 11, and the almost flat field where the anode plate 2 and the insulator layer 3 were located in a line by turns is acquired.

[0083] Next, as shown in drawing 6 (d), the hole-injection transporting bed 4, a luminous layer 5, and the electron-injection transporting bed 6 are deposited on an anode plate 2 and the front face of an insulator layer 3 one by one by the vacuum deposition. The quality of the material and thickness of the hole-injection transporting bed 4, a luminous layer 5, and the electron-injection transporting bed 6 are the same as what was explained by above-mentioned drawing 1 .

[0084] Next, as shown in drawing 6 (e), the metal mask 12 which has opening 13 to a cathode formation schedule field is formed in the front face of the electron-injection transporting bed 6. It lets opening 13 pass, for example, vapor codeposition of Mg and Ag is carried out, and the Mg-Ag cathode 7 with a thickness of 200nm is formed. Although the metal mask 12 is separated from the front face of the electron-injection transporting bed 6 and is drawn in drawing 6 (e) so that it may be easy to understand, the metal mask 12 is stuck on the front face of the electron-injection transporting bed 6 in practice.

[0085] Moreover, in drawing 6 (e) - (f), drawing 6 (a) - (d) shows the cross section of the right-angled direction, and it is made to be displayed in the cross section of the opening 13 of a mask 12, and two or more cathode 7. Since the front face of the electron-injection transporting bed 6 is a flat surface mostly, there is almost no crevice between the metal mask 12 and the electron-injection transporting bed 6, therefore it does not almost have a surroundings lump of the vacuum evaporationo particle at the time of cathode formation, and as cathode spread, it does not spread. Therefore, bleeding of luminescence is lost.

[0086] Next, as shown in drawing 6 (f), an insulator layer 8 is put on the front face of cathode 7, and the exposed surface of the electron-injection transporting bed 6 at the thickness of 300nm. As an insulator layer 8, organic insulators, such as a photosensitive polycarbonate used as the inorganic insulator or photoresist of SiO, SiO<sub>2</sub>, SiN, Si<sub>3</sub>N<sub>4</sub>, AlO<sub>2</sub> and aluminum 2O<sub>3</sub>, and Y<sub>2</sub>O<sub>3</sub> grade, polyester, and a polyimide, etc. can be used.

[0087] It explains using the cross section of drawing 7 having shown the gestalt and example of implementation of invention of the 5th of this invention in order of the process.

[0088] first, as shown in drawing 7 (a), ITO is transparent on a transparent substrate 1 like glass -- a conductor -- it is a vacuum deposition, for example, a film is formed in the thickness of 500nm besides the mask 11 of a photoresist is formed and transparent using this -- a conductor -- a film is \*\*\*\*\*ed and an anode plate 2 is formed An anode plate 2 is beltlike, sets an interval and are formed in parallel. [ two or more ] And the mask 11 of a photoresist is removed.

[0089] Next, as shown in drawing 7 (b), an insulator layer 3 is put on the same thickness as an anode plate 2. What is necessary is just to choose an insulator layer 3 from the matter shown in Table 2.

[0090] Next, as shown in drawing 7 (c), the insulator layer 3 on an anode plate 2 is removed by the chemical mechanical grinding method (the CMP method). The flat field where the anode plate 2 and the insulator layer 3 formed the same flat surface mostly, and were located in a line by this is acquired.

[0091] Next, as shown in drawing 7 (d), the hole-injection transporting bed 4 and the electron-injection transporting bed 6 are deposited on an anode plate 2 and the front face of an insulator layer 3. The quality of the material and thickness of the hole-injection transporting bed 4 and the electron-injection transporting bed 6 are the same as what was explained by drawing 4.

[0092] Next, as shown in drawing 7 (e), the metal mask 12 which has opening 13 is formed in the cathode formation schedule field of the front face of the electron-injection transporting bed 6. It lets opening 13 pass, for example, vapor codeposition of Mg and Ag is carried out, and the Mg-Ag cathode 7 is formed. Although the metal mask 12 is separated from the front face of the electron-injection transporting bed 6 and is drawn in drawing 7 (e) so that it may be easy to understand, the metal mask 12 is stuck on the front face of the electron-injection transporting bed 6 in practice.

[0093] Moreover, in drawing 7 (e) - (f), drawing 7 (a) - (d) shows the cross section of the right-angled direction, and it is made to be displayed in the cross section of the opening 13 of a mask 12, and two or more cathode 7. It is the same as the case of the 4th invention explained by drawing 6 (e) that there is almost no surroundings lump of the vacuum evaporationo particle at the time of cathode formation, do not spread as cathode spread, and bleeding of luminescence is lost.

[0094] Next, as shown in drawing 7 (f), an insulator layer 8 is put on the front face of cathode 7, and the exposed surface of the electron-injection transporting bed 6. The insulator layer 8 is the same as the case of the 4th invention explained by drawing 6 (e).

[0095]

[Effect of the Invention] As explained above, the organic EL element of this invention Since the insulator layer of the almost same thickness as an anode plate was prepared between anode plates and the level difference by the anode plate was made very small Each organic layer, such as a hole-injection transporting bed, a luminous layer, and an electron-injection transporting bed, turns into a layer of almost flat uniform thickness. Since a thin portion is not made, become uniform electric field, for this reason, the leakage current and dielectric breakdown stop being able to happen easily, and the electric field formed between an anode plate and cathode can prevent a cross talk and bleeding of luminescence. Moreover, since cathode is formed on a flat organic layer, it cannot do a thin portion but produces neither increase of resistance, nor an open circuit of cathode.

[0096] Moreover, since the organic EL element of this invention can reduce injection of the light to the field non-emitting light by choosing the refractive index of an insulator layer, it can reduce bleeding of luminescence.

[0097] Since the manufacture method of the organic EL element of this invention can form easily the insulator layer of the same thickness as an anode plate between anode plates, it can lose the level difference by the anode plate, and can manufacture the organic EL element which prevented a cross talk, bleeding of luminescence, increase of cathode resistance, and the open circuit.

[0098] Moreover, since the manufacture method of the organic EL element of this invention can use the lift-off method of a photoresist, it can form easily the insulator layer of the almost same thickness as an anode plate between anode plates.

[0099] Furthermore, since the manufacture method of the organic EL element of this invention can use the chemical mechanical grinding method, it can form easily the insulator layer of the almost same thickness as an anode plate between anode plates.

---

[Translation done.]